IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Patent Application of

KURAHASHI et al. | Atty. Ref.: 925-177

Serial No. 09/778,045 | TC/A.U.: 2811

Filed: February 7, 2001 | Examiner: Crane, S.

For: SEMICONDUCTOR LIGHT-EMITTING DEVICE AND MANUFACTURING METHOD THEREFOR

* *

May 2, 2005

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

Applicant hereby appeals to the Board of Patent Appeals and Interferences from the last decision of the Examiner.

(I)

(I) REAL PARTY IN INTEREST

The real party in interest is Sharp Kabushiki Kaisha, a corporation of the country of Japan.

(II) RELATED APPEALS AND INTERFERENCES

The appellant, the undersigned, and the assignee are not aware of any related appeals, interferences, or judicial proceedings (past or present), which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

(III) STATUS OF CLAIMS

Claims 1-8, 15-22 and 25-26 are pending and have been rejected. Claims 9-14 have been canceled. The Examiner has indicated that claims 23-24 contain allowable subject matter and would be allowable if rewritten in independent form (so claims 23-24 are not on appeal herein).

A complete listing as to status may be found in the Appendix hereto listing the claims.

(IV) STATUS OF AMENDMENTS

An Amendment After Final was filed December 8, 2004, but was not entered by the Examiner as evidenced by the Advisory Action dated January 10, 2005. Thus, the pending claims are those that were filed in the Amendment dated June 22, 2004.

(V) SUMMARY OF EXAMPLE EMBODIMENTS

For purposes of example and without limitation, certain example embodiments of this invention relate to a semiconductor light-emitting device (LED) which can reduce the radiation angle dependence of emission wavelength by providing a roughened surface that multi-directionally scatters light emitted from the light-emitting layer.

For example and without limitation, Fig. 2B of the instant application illustrates a semiconductor based LED including DBR (Distributed Bragg Reflector) 3 and a light-emitting layer(s) 5 supported by at least a substrate 1 comprising GaAs. As explained in the instant specification, the DBR 3 may be formed for example by stacking 20 or so pairs of layers of n-type $Al_{0.5}In_{0.5}P$ and n-type $(Al_{0.2}Ga_{0.8})_{0.5}In_{0.5}P$ alternately (e.g., pg. 16, lines 23-25). The DBR 3 is located between the substrate 1 comprising GaAs and the light-emitting layer 5, and light directed from the light-emitting layer 5 toward a top surface of the light-emitting device has a radiation angle dependence.

Also illustrated in Fig. 2B is a semiconductor layer 9 formed over at least the light-emitting layer 5, a top surface of the semiconductor layer 9 comprising a roughened surface which is not at least partially covered by the other semiconductor layers. The roughened top surface of semiconductor layer 9 causes light output from the light-emitting device to be diffused upon leaving the top surface of the device. Additionally, as shown in Fig. 2B, no DBR is provided between the light-emitting layer 5 and the semiconductor layer 9 having the top surface that is roughened.

In certain example embodiments of this invention, the semiconductor layer 9 whose top surface is roughened at least in part has a lattice constant different by 0.5% or more than that of the substrate comprising GaAs. The instant specification explains that

this lattice constant difference of 0.5% or more is highly advantageous in that it allows the wafer surface to be roughened by a sequence of crystal growth due to the lattice constant difference, thereby permitting a step of separately roughening the surface after crystal growth to be eliminated (e.g., pg. 8, lines 3-10; pg. 11, lines 5-18).

(VI) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1-8, 15-22 and 25-26 stand rejected under 35 U.S.C. Section 103(a) over Krames (US 5,779,924) in view of Saeki (US 6,350,997) and Vakshoori (US 5,426,657).

(VII) ARGUMENT

It is axiomatic that in order for a reference to anticipate a claim, it must disclose, teach or suggest each and every feature recited in the claim. See, e.g., Kalman v. Kimberly-Clark Corp., 713 F.2d 760, 218 USPQ 781 (Fed. Cir. 1983). The USPTO has the burden in this respect.

Moreover, the USPTO has the burden under 35 U.S.C. Section 103 of establishing a *prima facie* case of obviousness. In re Piasecki, 745, F.2d 1468, 1471-72, 223 USPQ 785, 787-88 (Fed. Cir. 1984). It can satisfy this burden only by showing that some objective teaching in the prior art, or that knowledge generally available to one of ordinary skill in the art, would have led that individual to combine the relevant teachings of the references to arrive at the claimed invention. In re Fine, 837 F.2d 1071, 1074, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). Before the USPTO may combine the disclosures of the references in order to establish a *prima facie* case of obviousness, there must be some suggestion for doing so. In re Jones, 958 F.2d 347 (Fed. Cir. 1992). Even assuming, *arguendo*, that a given combination of references is proper, the combination of references must in any event disclose the features of the claimed invention in order to render it obvious.

Claim 1

Claim 1 stands rejected under 35 U.S.C. Section 103(a) as being allegedly unpatentable over35 U.S.C. Section 103(a) as being allegedly unpatentable over Krames in view of Saeki and Vakhshoori. This 3-way Section 103(a) rejection should be reversed for at least the following reasons.

Claim 1 requires "a DBR (Distributed Bragg Reflector) and a light-emitting layer supported by at least a substrate comprising GaAs, the DBR being located between the substrate comprising GaAs and the light-emitting layer, wherein light directed from the light-emitting layer toward a top surface of the light-emitting device has a radiation angle dependence; a semiconductor layer formed over at least the light-emitting layer, a top surface of the semiconductor layer comprising a roughened surface which is not at least partially covered by the other semiconductor layers in order to cause light output from the light-emitting device to be diffused upon leaving the top surface of the device; and wherein no DBR is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened." For example and without limitation, Fig. 2B of the instant application illustrates a DBR (Distributed Bragg Reflector) 3 and a light-emitting layer(s) 5 supported by at least a substrate 1 comprising GaAs. The DBR 3 is located between the substrate 1 comprising GaAs and the light-emitting layer 5, and light directed from the light-emitting layer 5 toward a top surface of the light-emitting device has a radiation angle dependence. Also illustrated in Fig. 2B is a semiconductor layer 9 formed over at least the light-emitting layer 5, a top surface of the semiconductor layer 9 comprising a roughened surface which is not at least partially covered by the other semiconductor layers. The roughened top surface of semiconductor layer 9 causes light output from the light-emitting device to be diffused upon leaving the top surface of the device. Additionally, as shown in Fig. 2B, no DBR is provided between the light-emitting layer 5 and the semiconductor layer 9 having the top surface that is roughened.

Vakhshoori is entirely unrelated to the invention of claim 1. In particular, claim 1 requires that the top surface of the semiconductor layer is at least partially roughened in a

manner which causes "light output from the light-emitting device to be diffused upon leaving the top surface of the device." Vakhshoori teaches the opposite of claim 1 in this respect. Instead of causing output light to be diffused or scattered as called for in claim 1, Vakhshoori uses a type of roughness for the express purpose of causing output light to be *focused* (see Fig. 2; col. 1, lines 50-55; and col. 3, line 55). Those of ordinary skill in the art will appreciate that focusing is the *opposite* of diffusing (i.e., Vakhshoori discloses the opposite of what claim 1 requires). Thus, it can be seen that Vakhshoori teaches directly away from the invention of claim 1 and is unrelated to the same.

Furthermore, the Examiner's allegation regarding a mirror function teaching of Vakshoori in the final rejection is incorrect. In particular, the Office Action states that Vakshoori teaches that a mirror function can be obtained by a single layer (citing column 3, line 4), so that substitution of a DBR of Krames by a single layer would have been obvious. The Examiner's interpretation of Vakshoori is wrong in this respect. In contrast to the incorrect statements in the Office Action, the mirror function cannot be obtained by a single layer as alleged by the Examiner because a p-type AlGaAs upper mirror (12) is also disclosed at col. 3, line 8, as clearly shown in Fig. 1. In other words, to achieve a mirror, Vakshoori requires *both* a lower mirror layer of n+ AlGaAs (col. 3,line 4) and an upper mirror layer of p-type AlGaAs (col. 3, line 8). A single layer cannot achieve mirror functionality in Vakshoori. Thus, in direct contrast to the Examiner's unsupported allegation, the mirror function in Vakshoori is achieved by a pair of mirrors – not a single mirror. This means that the device of Vakshoori is an RCLED which is the *opposite* of what the invention of claim 1 requires (since claim 1 requires that no DBR is provided between the light-emitting layer and the semiconductor layer having the top surface that

is roughened). The very basis of the Section 103(a) rejection is based on a misunderstanding of the cited art, thereby evidencing that the Section 103(a) rejection is incorrect and should be withdrawn.

The Office Action also relies on Fig. 13 of Krames. However, in direct contrast to claim 1, the device shown in Fig. 13 of Krames is an RC (Resonance Cavity)-LED necessarily having by definition both an upper DBR (20B) and a lower DBR (20A) (col. 9, lines 5-15). Contrary to what is alleged in the Office Action, one of ordinary skill in the art would never even consider removing the upper DBR from Fig. 13 of Krames as alleged in the Office Action, because this upper DBR is an absolute requirement of the device and its removal would destroy the functionality of the device. In other words, one of ordinary skill in the art would never have removed the upper DBR from Fig. 13 of Krames as alleged in the Office Action, because this would destroy the functionality and operation of Krames' RCLED.

The Office Action also contends that it would have been obvious to have "texture[d] the top surface of the device of Saeki Fig. 8B as taught by Krames et al. with respect to figure 13." This contention is respectfully traversed. The device of Saeki is designed to reduce the operation voltage and increase optical output. To achieve this, a contact layer (22) doped with carbon for reducing the contact resistance with ITO electrode (16) is provided and an intermediate band gap layer (21) is interposed between the contact layer (22) and the cladding layer (15) for alleviating band discontinuity, thereby promoting inflow of holes and decreasing resistance. Consequently, the need is met by the use of such layers and there would have been no need to further enhance light emission by texturing the top surface of the device.

Moreover, the ordered textures of Krames in Fig. 13 are designed to efficiently couple emitted light into ambient (col. 9, lines 5-10), which is much different than the scattering function required by claim 1. The Examiner relies on Fig. 13 of Krames for alleged diffusion. In particular, the Examiner has contended that diffusion, or spreading out, of the emission profile is shown in Figure 13 of Krames et al., for example, where the lobes of the profile indicate the spread. *The Examiner has misinterpreted Krames in this regard*; Krames discloses no diffusing or scattering. In particular, the lobes in Krames indicate only the spreading spectrum of the emitted light from the active region (2) and they are not scattered or diffused as called for in claim 1 because they have not yet reached the surface. Again, the basis of the Section 103(a) rejection is incorrect, thereby evidencing that the Section 103(a) rejection in incorrect and should be withdrawn.

On page 3 of the Office Action, the Examiner states that "applicant argues that the Vakshoori reference does not teach that a single layer can function as a mirror." In this respect, applicant does not argue that the lower mirror (11) of Vakshoori does not function as a mirror. The point is that it does not function as a resonator itself and does not perform emitting light as a whole in this respect if the upper mirror (12) is removed.

Also on page 3 of the Office Action, the Examiner states that "the differences in function would be precisely what would motivate a designer to choose one configuration or the other . . . the function of emitting light is not 'destroyed' in either case." In response, it is pointed out that one may choose between a RCLED, and an LED with only a lower DBR. However, once an RCLED is chosen (Krames chose an RCLED), one would never remove the upper DBR because then it would not properly emit light and its

function would be destroyed. Thus, one of ordinary skill in the art would never have made the combination alleged in the Office Action. Not only is there a lack of suggestion in the cited art for the alleged combination, but the alleged combination would actually cause failure of functionality of the base reference device, thereby evidencing that one of ordinary skill in the art would not have made the 3-way combination alleged in the final rejection. No prima facie case of obviousness has been presented.

For at least the aforesaid reasons, it is respectfully requested that the rejection of claim 1 be reversed.

Claim 8

Claim 8 requires that the semiconductor with roughened surface has a lattice constant different by 0.5% or more than that of the substrate comprising GaAs. The cited art fails to disclose or suggest this feature of claim 8.

The instant specification explains that this lattice constant difference of 0.5% or more is highly advantageous in that it allows the wafer surface to be roughened by a sequence of crystal growth due to the lattice constant difference, thereby permitting a step of separately roughening the surface after crystal growth to be eliminated (e.g., pg. 8, lines 3-10; pg. 11, lines 5-18).

The cited art fails to disclose or suggest the aforesaid feature of claim 8. There is no disclosure or suggestion of this feature in the cited art.

On page 2 of the final rejection, it is argued by the Examiner that "differences in lattice constants as recited would have been obvious in order to allow for different types of semiconductor layers within the device that give rise to different desired wavelength outputs." This contention is respectfully traversed. The instant specification establishes

unexpected results and criticality as to this range, and explains that this lattice constant difference of 0.5% or more is highly advantageous in that it allows for example the wafer surface to be roughened by a sequence of crystal growth due to the lattice constant difference thereby permitting a step of separately roughening the surface after crystal growth to be eliminated (e.g., pg. 8, lines 3-10; pg. 11, lines 5-18). There is absolutely nothing in the cited art which discloses or suggests this claimed range. Moreover, this difference in lattice constant may be used in certain example non-limiting embodiments in order to obtain a roughened surface via a sequence of crystal growth. This is clearly not a matter of routine design choice, and no prima facie case of obviousness has been made.

Claim 15

Claim 15 states that "a roughened surface which is not at least partially covered by the other semiconductor layers in order to cause light output from the light-emitting device to be diffused upon leaving the top surface of the device; and wherein no DBR is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened." The cited art fails to disclose or suggest these aspects of claim 15.

Claim 15 requires that the top surface is at least partially roughened in a manner which causes light output from the light-emitting device to be diffused upon leaving the top surface of the device. Vakhshoori teaches the opposite of claim 15 in this respect. Instead of causing output light to be diffused or scattered as called for in claim 15, Vakhshoori uses a type of roughness for the express purpose of causing output light to be *focused* (see Fig. 2; col. 1, lines 50-55; and col. 3, line 55) – again, this is the opposite of

what the claim requires. Thus, Vakhshoori teaches directly away from the invention of claim 1 and is unrelated to the same, thereby evidencing that the Section 103(a) combination lacks merit.

As noted above, the Examiner's allegation regarding a mirror function teaching of Vakshoori in the final rejection is incorrect. In particular, the Office Action states that Vakshoori teaches that a mirror function can be obtained by a single layer (citing column 3, line 4), so that substitution of a DBR of Krames by a single layer would have been obvious. The Examiner's interpretation of Vakshoori is wrong in this respect. In contrast to the incorrect statements in the Office Action, the mirror function cannot be obtained by a single layer as alleged by the Examiner because a p-type AlGaAs upper mirror (12) is also disclosed at col. 3, line 8, as clearly shown in Fig. 1. In other words, to achieve a mirror, Vakshoori requires *both* a lower mirror layer of n+ AlGaAs (col. 3,line 4) and an upper mirror layer of p-type AlGaAs (col. 3, line 8). A single layer cannot achieve mirror functionality in Vakshoori. Thus, in direct contrast to the Examiner's unsupported allegation, the mirror function in Vakshoori is achieved by a pair of mirrors – not a single mirror. This means that the device of Vakshoori is an RCLED which is the *opposite* of what the invention of claim 15 requires (since claim 15 requires that no DBR is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened). Again, the very basis of the Section 103(a) rejection is based on a misunderstanding of the cited art, thereby evidencing that the Section 103(a) rejection is incorrect and should be withdrawn.

Also, as explained above, the device shown in Fig. 13 of Krames is an RC (Resonance Cavity)-LED necessarily having by definition both an upper DBR (20B) and

a lower DBR (20A) (col. 9, lines 5-15). Contrary to what is alleged in the Office Action, one of ordinary skill in the art would never even consider removing the upper DBR from Fig. 13 of Krames as alleged in the Office Action, because this upper DBR is an absolute requirement of the device to function properly, and its removal would destroy the functionality of the device.

The Office Action also contends that it would have been obvious to have "texture[d] the top surface of the device of Saeki Fig. 8B as taught by Krames et al. with respect to figure 13." This contention is respectfully traversed. The device of Saeki is designed to reduce the operation voltage and increase optical output. To achieve this, a contact layer (22) doped with carbon for reducing the contact resistance with ITO electrode (16) is provided and an intermediate band gap layer (21) is interposed between the contact layer (22) and the cladding layer (15) for alleviating band discontinuity, thereby promoting inflow of holes and decreasing resistance. Consequently, the need is met by the use of such layers and there would have been no need to further enhance light emission by texturing the top surface of the device. Moreover, the ordered textures of Krames in Fig. 13 are designed to efficiently couple emitted light into ambient (col. 9, lines 5-10), which is much different than the diffusing or scattering function required by claim 15.

Furthermore, the Examiner relies on Fig. 13 of Krames for alleged diffusion. In particular, the Examiner has contended that diffusion, or spreading out, of the emission profile is shown in Figure 13 of Krames et al., for example, where the lobes of the profile indicate the spread. *The Examiner has misinterpreted Krames in this regard*; Krames discloses no diffusing or scattering. In particular, the lobes in Krames indicate only the

spreading spectrum of the emitted light from the active region (2) and they are not scattered or diffused as called for in claim 15 because they have not yet reached the surface. Again, the basis of the Section 103(a) rejection is incorrect, thereby evidencing that the Section 103(a) rejection in incorrect and should be withdrawn.

On page 3 of the Office Action, the Examiner states that "the differences in function would be precisely what would motivate a designer to choose one configuration or the other . . . the function of emitting light is not 'destroyed' in either case." In response, it is pointed out that one may choose between an RCLED, and an LED with only a lower DBR. However, once an RCLED is chosen (Krames chose an RCLED), one would never remove the upper DBR because then it would not properly emit light and its function would be destroyed. Thus, one of ordinary skill in the art would never have made the combination alleged in the Office Action. Not only is there a lack of suggestion in the cited art for the alleged combination, but the alleged combination would actually cause failure of functionality of the base reference device, thereby evidencing that one of ordinary skill in the art would not have made the 3-way combination alleged in the final rejection. No prima facie case of obviousness has been presented.

Claim 21

Claim 21 requires that "the semiconductor with roughened surface has a lattice constant different by 0.5% or more than that of the substrate comprising GaAs." The cited art fails to disclose or suggest this aspect of claim 21.

The instant specification explains that this lattice constant difference of 0.5% or more is highly advantageous in that it allows the wafer surface to be roughened by a sequence of crystal growth due to the lattice constant difference, thereby permitting a step

of separately roughening the surface after crystal growth to be eliminated (e.g., pg. 8, lines 3-10; pg. 11, lines 5-18). The cited art fails to disclose or suggest the aforesaid feature of claim 21. There is no disclosure or suggestion of this feature in the cited art.

On page 2 of the final rejection, it is argued by the Examiner that "differences in lattice constants as recited would have been obvious in order to allow for different types of semiconductor layers within the device that give rise to different desired wavelength outputs." This contention is respectfully traversed. The instant specification establishes unexpected results and criticality as to this range, and explains that this lattice constant difference of 0.5% or more is highly advantageous in that it allows for example the wafer surface to be roughened by a sequence of crystal growth due to the lattice constant difference thereby permitting a step of separately roughening the surface after crystal growth to be eliminated (e.g., pg. 8, lines 3-10; pg. 11, lines 5-18). There is absolutely nothing in the cited art which discloses or suggests this claimed range. Moreover, this difference in lattice constant may be used in certain example non-limiting embodiments in order to obtain a roughened surface via a sequence of crystal growth. This is clearly not a matter of routine design choice, and no prima facie case of obviousness has been made.

Claim 22

Claim 22 defines over the cited art for the reasons discussed above with respect to claim 21.

Claim 25

Claim 25 requires that "no mirror/reflector is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened." The cited art fails to disclose or suggest this.

The Office Action contends that it would have been obvious to have replaced the upper DBR of Krames with the mirror/reflector of Vakhshoori (this alleged modification has been traversed above). However, even if this modification were made, the invention of claim 25 still would not be met. There would still be a reflector between the light emitting layer and the roughened surface, which is expressly excluded by this claim. Thus, even the alleged combination set forth in the Office Action (which applicant believes would be incorrect in any event) fails to meet the invention of this claim.

On page 2 of the Office Action, it is argued by the Examiner with respect to claims 25-26 that Saeki "motivates leaving out the top DBR of the Krames device, if the function of this structure is not desired." This allegation is respectfully traversed. Krame's device is an RC (Resonant Cavity) LED having the active layer (2) interposed between the upper and lower DBRs (20A, 20B) as shown in Fig. 13. Both DBRs in Krames are required, and they are both indispensable for the emitted light to be resonated as an available output light. Thus, the function of both DBRs is required, and to remove one of them as alleged in the Office Action is unthinkable and would destroy the function of the base device. The Section 103(a) rejection is incorrect and lacks merit, as there is no suggestion in the cited art for the alleged combination and no prima facie case of obviousness has been made. Hindsight is not permitted.

Claim 26

Claim 26 requires that "no mirror/reflector is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened." The cited art fails to disclose or suggest this.

The Office Action contends that it would have been obvious to have replaced the upper DBR of Krames with the mirror/reflector of Vakhshoori (this alleged modification has been traversed above). However, even if this modification were made, the invention of claim 26 still would not be met. There would still be a reflector between the light emitting layer and the roughened surface, which is expressly excluded by this claim. Thus, even the alleged combination set forth in the Office Action (which applicant believes would be incorrect in any event) fails to meet the invention of this claim.

On page 2 of the Office Action, it is argued by the Examiner with respect to claims 25-26 that Saeki "motivates leaving out the top DBR of the Krames device, if the function of this structure is not desired." This allegation is respectfully traversed. Krame's device is an RC (Resonant Cavity) LED having the active layer (2) interposed between the upper and lower DBRs (20A, 20B) as shown in Fig. 13. Both DBRs in Krames are required, and they are both indispensable for the emitted light to be resonated as an available output light. Thus, the function of both DBRs is required, and to remove one of them as alleged in the Office Action is unthinkable and would destroy the function of the base device. The Section 103(a) rejection is incorrect and lacks merit, as there is no suggestion in the cited art for the alleged combination and no prima facie case of obviousness has been made. Hindsight is not permitted.

CONCLUSION

In conclusion it is believed that the application is in clear condition for allowance; therefore, early reversal of the Final Rejection and passage of the subject application to issue are earnestly solicited.

Respectfully submitted,

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(VIII) CLAIMS APPENDIX

1. A semiconductor light-emitting device comprising:

a DBR (Distributed Bragg Reflector) and a light-emitting layer supported by at least a substrate comprising GaAs, the DBR being located between the substrate comprising GaAs and the light-emitting layer, wherein light directed from the light-emitting layer toward a top surface of the light-emitting device has a radiation angle dependence;

a semiconductor layer formed over at least the light-emitting layer, a top surface of the semiconductor layer comprising a roughened surface which is not at least partially covered by the other semiconductor layers in order to cause light output from the light-emitting device to be diffused upon leaving the top surface of the device; and

wherein no DBR is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened.

2. The semiconductor light-emitting device according to claim 1, wherein the light-emitting layer to be formed on the GaAs substrate is a single layer or a plurality of layers made of $Al_yGa_zIn_{1-y-z}P$ ($0 \leq y \leq 1$, $0 \leq z \leq 1$).

3. The semiconductor light-emitting device according to claim 1, wherein the semiconductor layer whose top surface is a roughened surface is made of $Al_xGa_{1-x}As$ ($0 \leq x \leq 1$).

4. The semiconductor light-emitting device according to claim 3, wherein the semiconductor layer made of $Al_xGa_{1-x}As$ ($0 \leq x \leq 1$) is transparent to an emission wavelength.

5. The semiconductor light-emitting device according to claim 3, wherein the semiconductor layer made of $Al_xGa_{1-x}As$ ($0 \leq x \leq 1$) has an Al mixed crystal ratio x of 0.5 - 0.8.

6. The semiconductor light-emitting device according to claim 3, further comprising an $Al_yGa_zIn_{1-y-z}P$ ($0 \leq y \leq 1$, $0 \leq z \leq 1$) layer for diffusing a current injected from an electrode provided on a light takeout side, the $Al_yGa_zIn_{1-y-z}P$ layer being provided between the semiconductor layer made of $Al_xGa_{1-x}As$ ($0 \leq x \leq 1$) and the light-emitting layer.

7. The semiconductor light-emitting device according to claim 1, wherein the layer whose top surface is a roughened surface is made of $Al_yGa_zIn_{1-y-z}P$ ($0 \leq y \leq 1$, $0 \leq z \leq 1$).

8. The semiconductor light-emitting device according to claim 7, wherein the layer whose top surface is a roughened surface has a lattice constant different by 0.5% or more from that of the GaAs substrate.

9-14. (Canceled)

15. A semiconductor light-emitting device comprising:

a DBR (Distributed Bragg Reflector) and a light-emitting layer supported by a substrate comprising GaAs, the DBR being located closer to the substrate comprising GaAs than is the light-emitting layer; and

a semiconductor layer formed on the light-emitting layer, and wherein at least part of a top surface of the semiconductor layer is roughened so as to define a roughened surface which is not at least partially covered by the other semiconductor layers in order to cause light output from the light-emitting device to be diffused upon leaving the top surface of the device; and

wherein no DBR is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened.

16. The semiconductor light-emitting device according to claim 15, wherein the light-emitting layer is a single layer or a plurality of layers comprising $Al_yGa_zIn_{1-y-z}P$ $(0 \le y \le 1, 0 \le z \le 1)$.

17. The semiconductor light-emitting device according to claim 15, wherein the semiconductor layer whose top surface is a roughened surface comprises $Al_xGa_{1-x}As$ $(0 \le x \le 1)$.

18. The semiconductor light-emitting device according to Claim 17, wherein the semiconductor layer comprising $Al_xGa_{1-x}As$ $(0 \le x \le 1)$ is transparent to an emission wavelength.

19. The device of claim 15, further comprising a current diffusion layer located between at least the light-emitting layer and the semiconductor having the top surface that is roughened, and an etch stop layer provided between the current diffusion layer and said semiconductor layer having the top surface that is roughened.

20. The device of claim 15, wherein the device includes only one DBR.

21. The light-emitting device of claim 1, wherein the semiconductor with roughened surface has a lattice constant different by 0.5% or more than that of the substrate comprising GaAs.

22. The light-emitting device of claim 15, wherein the semiconductor with roughened surface has a lattice constant different by 0.5% or more than that of the substrate comprising GaAs.

23. ***(Allowable Subject Matter – Not on Appeal)*** The light-emitting device of claim 1, wherein a top electrode of the device includes a plurality of separate apertures defined therein so as to expose different parts of the roughened surface of the semiconductor layer.

24. ***(Allowable Subject Matter – Not on Appeal)*** The light-emitting device of claim 15, wherein a top electrode of the device includes a plurality of separate apertures

defined therein so as to expose different parts of the roughened surface of the semiconductor layer.

25. The light-emitting device of claim 1, wherein no mirror/reflector is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened.

26. The light-emitting device of claim 15, wherein no mirror/reflector is provided between the light-emitting layer and the semiconductor layer having the top surface that is roughened.